O I P E
DEC 1 6 2004
JC99
PATENT & TRADEMARK OFFICE

12-17-04
EV554735763
AF/2672$
IFW

PTO/SB/21 (08-03)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	09/451,256
Filing Date	11/29/1999
First Named Inventor	Steven R. Hollasch
Group Art Unit	2672
Examiner Name	JAVID A AMINI
Attorney Docket Number	MS1-448US
Total Number of Pages in This Submission	

ENCLOSURES (check all that apply)

- [x] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment / Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Documents
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s)
- [ ] After Allowance Communication to Group
- [ ] Appeal Communication to Board of Appeals and Interferences
- [x] Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) *(please identify below):* *Return postcard*

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm or Individual Name	Lance R. Sadler, Reg. No. 38605
Signature	[signature]
Date	12/16/04

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Typed or printed name	Carly Taylor		
Signature	Carly Taylor	Date	12/16/04

OIPE JC99 DEC 1 6 2004 PATENT & TRADEMARK OFFICE

EV554735763

PTO/SB/17 (12-04)
Approved for use through 07/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2005

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($) 500.00

Complete if Known	
Application Number	09/451,256
Filing Date	11/29/1999
First Named Inventor	Hollasch
Examiner Name	Amini, J.
Art Unit	2672
Attorney Docket No.	MS1-448US

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ____________

☑ Deposit Account Deposit Account Number: 12-0769 Deposit Account Name: Lee & Hayes, PLLC

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	FILING FEES Small Entity Fee ($)	SEARCH FEES Fee ($)	SEARCH FEES Small Entity Fee ($)	EXAMINATION FEES Fee ($)	EXAMINATION FEES Small Entity Fee ($)	Fees Paid ($)
Utility	300	150	500	250	200	100	
Design	200	100	100	50	130	65	
Plant	200	100	300	150	160	80	
Reissue	300	150	500	250	600	300	
Provisional	200	100	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 or, for Reissues, each claim over 20 and more than in the original patent	50	25
Each independent claim over 3 or, for Reissues, each independent claim more than in the original patent	200	100
Multiple dependent claims	360	180

Total Claims ______ - 20 or HP = **Extra Claims** ______ x **Fee ($)** 50 = **Fee Paid ($)** ______

HP = highest number of total claims paid for, if greater than 20

Indep. Claims ______ - 3 or HP = **Extra Claims** ______ x **Fee ($)** 200 = **Fee Paid ($)** ______

HP = highest number of independent claims paid for, if greater than 3

Multiple Dependent Claims **Fee ($)** ______ **Fee Paid ($)** ______

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets ______ - 100 = **Extra Sheets** ______ / 50 = **Number of each additional 50 or fraction thereof** ______ (round **up** to a whole number) x **Fee ($)** ______ = **Fee Paid ($)** ______

4. OTHER FEE(S) **Fees Paid ($)**

Non-English Specification, $130 fee (no small entity discount) ______

Other: Appeal Brief 500.00

SUBMITTED BY					
Signature	[signature]	Registration No. (Attorney/Agent)	38,605	Telephone	(509) 324-9256
Name (Print/Type)	Lance R. Sadler			Date	12/16/04

This collection of information is required by 37 CFR 1.136. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

EV554735763

OIPE JC69 DEC 1 6 2004 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application Serial No. 09/451,256
Filing Date .... November 29, 1999
Inventor .... Hollasch
Group Art Unit 2672
Examiner .... Amini, Javid A
Attorney's Docket No. MS1-448US
Confirmation No 8802
Title: "Computer Graphics Methods and Apparatus for Ray Intersection"

APPEAL BRIEF

To: Commissioner for Patents
PO Box 1450
Alexandria, Virginia 22313-1450

From: Lance R. Sadler (Tel. 509-324-9256 x 226; Fax 509-323-8979)
Customer No. 22801

Pursuant to 37 C.F.R. §41.37, Applicant hereby submits an appeal brief for application 09/451,256, filed November 29, 1999, within the requisite time from the date of filing the Notice of Appeal. Accordingly, Applicant appeals to the Board of Patent Appeals and Interferences seeking review of the Examiner's rejections.

12/21/2004 AWONDAF1 00000084 120769 09451256
01 FC:1402 500.00 DA

Appeal Brief Items **Page**

(1) Real Party in Interest

The real party in interest is Microsoft Corporation, the assignee of all right, title and interest in and to the subject invention.

(2) Related Appeals and Interferences

Appellant is not aware of any other appeals, interferences, or judicial proceedings which will directly affect, be directly affected by, or otherwise have a bearing on the Board's decision to this pending appeal.

(3) Status of Claims

Claims 1-56 stand rejected and are pending in this Application. Claims 1-56 are appealed. Claims 1-23, 27-30, 34-39, 41-56 are original claims and hence bear the designator "(Original)". Claims 24-26, 31-33, 40 were previously amended and hence bear the designator "(Previously Presented").

Claims 1-56 are set forth in the Appendix of Appealed Claims on page 59.

(4) Status of Amendments

A Final Office Action was issued on August 6, 2004.

No amendments were made to the claim subsequent to the final rejection.

(5) Summary of Claimed Subject Matter

A concise explanation of each of the independent claims is included in this Summary section, including specific reference characters. These specific reference characters are examples of particular elements of the drawings for

certain claimed embodiments. It is to be appreciated and understood that the claims are not to be limited to solely the elements corresponding to these reference characters and that this section is provided to comply with the requirement of 37 CFR § 41.37(c)(i)(v).

Claim 1 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray (Fig. 3) is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308) each characterized by characteristic data, a method for determining which of the shapes (302, 304, 306, 308) are intersected by the ray, the method comprising: defining a reference object (Fig. 3: Plane) relative to the represented object; determining the positions of the shapes (302, 304, 306, 308) relative to the reference object using the characteristic data; and determining, on the basis of the positions of the shapes (302, 304, 306, 308) relative to the reference object (Plane), those shapes that have no chance (306, 308) of intersecting the ray, and those remaining shapes that may intersect (302, 304) the ray.

Claim 16 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray (Fig. 3) is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a collection (300) of polygons that approximate an object, individual polygons having a plurality of vertices (Fig. 3: V_1-V_7); casting a ray (Fig. 3: Ray) toward the approximated object; defining a reference object (Fig. 3: Plane) relative to the collection (300) of polygons and that contains the cast ray; pre-characterizing at least some vertices (Fig. 3: V_1-V_7) of at least some of the

polygons to provide characteristic data that describes the vertices' positions relative to the reference object (Fig. 3: Plane) ; and using the characteristic data to ascertain the positions of the individual polygons relative to the reference object (Fig. 3: Plane).

Claim 24 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16), in which a ray (Fig. 3) is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a collection (300) of polygons (302, 304, 306, 308) that approximate an object, individual polygons having a plurality of vertices (Fig. 3: V_1-V_7); casting a ray (Fig. 3: Ray) toward the approximated object; defining a reference object (Fig. 3: Plane) relative to the collection (300) of polygons and that contains the cast ray; pre-characterizing at least some vertices (Fig. 3: V_1-V_7) of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object (Fig. 3: Plane); and using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set of polygons that might be intersected by the ray.

Claim 25 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16), in which a ray (Fig. 3) is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a collection (300) of polygons that approximate an object,

individual polygons having a plurality of vertices (Fig. 3: V_1-V_7); casting a ray (Fig. 3: Ray) toward the approximated object; defining a reference object (Fig. 3: Plane) relative to the collection (300) of polygons and that contains the cast ray; pre-characterizing at least some vertices (Fig. 3: V_1-V_7) of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object (Fig. 3: Plane); and using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set (302, 304) of polygons at least some of which straddle the reference object (Fig. 3: Plane).

Claim 26 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray (Fig. 3) is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a collection (300) of polygons (302, 304, 306, 308) that approximate an object, individual polygons having a plurality of vertices (Fig. 3: V_1-V_7); casting a ray (Fig. 3: Ray) toward the approximated object; defining a reference object (Fig. 3: Plane) relative to the collection (300) of polygons and that contains the cast ray; pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object (Fig. 3: Plane); using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set (302, 304) of polygons at least some of which

straddle the reference object (Fig. 3: Plane); and evaluating the sub-set (302, 304) of polygons to determine which polygons are intersected by the ray.

Claim 27 recites in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray (Fig. 3) is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a plurality of triangles (302, 304, 306, 308) that approximate an object, individual triangles having three vertices (Fig. 3: V_1-V_7); casting a ray (Fig. 3) toward the approximated object; defining at least one plane (Fig. 3: Plane) relative to the approximated object to contain the ray; pre-characterizing the vertices (Fig. 3: V_1-V_7) of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane (Fig. 3: Plane); and using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane.

Claim 31 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a plurality of triangles (302, 304, 306, 308) that approximate an object, individual triangles having three vertices (Fig. 3: V_1-V_7); casting a ray (Fig. 3: Ray) toward the approximated object; defining at least one plane (Fig. 3: Plane) relative to the approximated object to contain the ray; pre-characterizing the vertices (Fig. 3: V_1-V_7) of the plurality of triangles to provide characteristic data that describes the positions of the vertices (Fig. 3: V_1-V_7) relative to said at

least one plane; and using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane (Fig. 3: Plane), wherein said using of the characteristic data comprises determining whether a particular individual triangle has a chance of being intersected by the ray.

Claim 32 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a plurality of triangles (302, 304, 306, 308) that approximate an object, individual triangles having three vertices (Fig. 3: V_1-V_7); casting a ray (Fig. 3: Ray) toward the approximated object; defining at least one plane (Fig. 3: Plane) relative to the approximated object to contain the ray; pre-characterizing the vertices (Fig. 3: V_1-V_7) of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane; and using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises determining whether a particular individual triangle straddles said at least one plane (Fig. 3: Plane).

Claims 33 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray is cast toward an object represented by a collection (300) of pre-determined shapes (302, 304, 306, 308), a method for determining which of the shapes are intersected by the ray, the method comprising: defining a plurality of triangles (302, 304, 306, 308) that approximate an object, individual triangles having three vertices (Fig. 3: V_1-V_7); casting a ray

(Fig. 3: Ray) toward the approximated object; defining at least one plane (Fig. 3: Plane) relative to the approximated object to contain the ray; pre-characterizing the vertices (Fig. 3: V_1-V_7) of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane (Fig. 3: Plane); using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises defining a sub-set of triangles at least some of which straddle the plane; and evaluating the sub-set of triangles to ascertain which triangles are intersected by the ray.

Claim 37 recites, in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray is cast toward an object represented by a collection (300) of pre-determined polygons (302, 304, 306, 308), a method for determining which of the polygons are intersected by the ray, the method comprising: defining a sub-set of polygons from a collection of polygons that approximate an object by determining which polygons have vertices (Fig. 3: V_1-V_7) that satisfy a predefined relationship relative to a reference object (Fig. 3: Plane); and evaluating the sub-set of polygons to ascertain which of the polygons is intersected by a cast ray.

Claim 40 recites in a computer graphic processing system (page 5 line 14 through page 8, line 16) in which a ray is cast toward an object represented by a collection (300) of pre-determined polygons (302, 304, 306, 308), a method for determining which of the polygons are intersected by the ray, the method comprising: defining a sub-set of polygons from a collection of polygons that approximate an object by determining which polygons have vertices (Fig. 3: V_1-

V_7) that satisfy a predefined relationship relative to a reference object, wherein the reference object comprises a plane (Fig. 3); and evaluating the sub-set of polygons to ascertain which of the polygons is intersected by a cast ray, wherein said determining comprises determining which polygons straddle the plane.

Claim 43 recites a computer graphic processing system (page 5 line 14 through page 8, line 16) comprising a programmable computer programmed with computer-readable instructions which, when executed by the programmable computer, implement the following method: defining a plurality of polygons (302, 304, 306, 308) that approximate an object, individual polygons having a plurality of vertices (Fig. 3: V_1-V_7); casting a ray toward the approximated object; defining at least one plane (Fig. 3) relative to the approximated object to contain the ray; pre-characterizing the vertices (Fig. 3: V_1-V_7) of the plurality of polygons (302, 304, 306, 308) to provide characteristic data that describes the positions of the vertices relative to said at least one plane; using the characteristic data to ascertain the positions of the individual polygons relative to said at least one plane; determining which of the individual polygons (302, 304, 306, 308) might be intersected by the ray, based upon their ascertained positions, to provide a sub-set of polygons; and evaluating the sub-set of polygons to ascertain which of the polygons are intersected by the ray.

Claim 48 recites one or more computer-readable media having computer-readable instructions thereon which, when executed by a computer graphic processing system (page 5 line 14 through page 8, line 16), implement the following method: defining a plurality of triangles (302, 304, 306, 308) that approximate an object, individual triangles having three vertices (Fig. 3: V_1-V_7);

casting a ray toward the approximated object; defining at least one plane (Fig. 3) relative to the approximated object to contain the ray; pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices (Fig. 3: V_1-V_7) relative to said at least one plane (Fig. 3); using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane; determining which of the individual triangles might be intersected by the ray, based upon their ascertained positions, to provide a sub-set of triangles; and evaluating the sub-set of triangles to ascertain which of the triangles are intersected by the ray.

Claim 50 recites a computer graphic processing system (page 5 line 14 through page 8, line 16) comprising: a processor (132); memory (134); and software code (160, 162, 164) stored in the memory that causes the processor to implement a ray-intersection algorithm which: casts a ray at a collection of shapes (302, 304, 306, 308) that approximate an object; defines a reference object (Fig. 3: Plane) that contains the ray; pre-characterizes aspects of individual ones of the shapes of the collection to provide characteristic data; and uses the characteristic data to ascertain the position of the shapes of the collection of shapes relative to the reference object.

<u>(6) Grounds of Rejection to be Reviewed on Appeal</u>

Claims 1-22, 24-33, and 35-56 stand rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,249,287 to Yamrom.

Claims 23 and 34 stand rejected under 35 U.S.C. § 112, first paragraph, as being based on a disclosure which is not enabling.

(7) Argument

A. Rejection under 35 U.S.C. §102(e) over U.S. Patent No. 6,249,287 to Yamrom

Claims 1-22, 24-33, and 35-56 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Yamrom. Perhaps a good starting point for appreciating the context and subject matter of Applicant's disclosure and claimed embodiments is in the "Background" section of the application.

There, Applicant discusses one of the issues or problems that pertain to ray intersection techniques. Specifically, Applicant instructs that a majority of the processing that takes place in connection with ray-intersection concerns searching for an object that is intersected by a cast ray. Where particular surfaces of objects are approximated by a plurality of shapes, e.g. triangles, conventional searching takes place by determining whether or not each and every shape that constitutes the approximated surface of an object is intercepted by the cast ray. For example, if the surface of an object is approximated by 6500 triangles, conventional searching algorithms test a first triangle to determine whether the cast ray intercepts it. If the first triangle is not intercepted by the cast ray, then the next triangle is tested and so on. Needless to say, processing each of the shapes used to approximate the surface of an object, while effective, is not the most optimal approach to the problem.

Applicant's disclosure then goes on to describe a number of embodiments that are directed to improving upon this past approach. More specifically, in accordance with various embodiments described in Applicant's specification, a

collection of shapes is first defined that approximates an object. Examples of such shapes include polygons and, in some examples, triangles. The specification instructs that various topologies can be used including triangle meshes, triangle strips, and triangle fans (see, e.g. Applicant's Figs. 4, 5 and 6).

In accordance with the described embodiments, a ray is cast toward the approximated object. A reference object which, in the illustrated example comprises a plane, is defined to contain the ray. For an example of a collection of shapes, a ray, and a plane that contains the ray, attention is directed to Applicant's Figs. 3 and 8.

With the plane and ray having been defined, aspects of the individual shapes are pre-characterized to provide characteristic data. In the illustrated example, pre-characterization takes place by testing each of the vertices of the polygons that make up the approximated object to ascertain their position relative to the reference object. With all of the vertices having been pre-characterized, the characteristic data is used to ascertain the position of the shapes relative to the reference object. This defines a sub-set of shapes that ***might*** be intersected by the ray. For an example of shapes that ***might*** be intersected by the ray in accordance with the above-described processing, the reader is referred to Fig. 9. There, a sub-set of shapes that ***might*** be intersected by the ray is shaded for clarity.

The sub-set of shapes (i.e. those shapes that are shaded in the Fig. 9 example) is then evaluated to ascertain which of the shapes is intersected by the ray. For an example of a shape that is intersected by the ray, the reader is referred to Fig. 10. By pre-characterizing the vertices of the polygons, certain polygons are ruled out before they are processed by an intersection algorithm.

Turning now to a discussion of Yamrom, consider the following. Yamrom is not concerned with nor does it pertain to the problem or solution that Applicant's disclosure respectively addresses and presents—that of reducing processing complexities associated with ray-intersection by ruling out certain shapes that represent an object before the shapes are processed by an intersection algorithm. Understanding that Yamrom is not concerned with the same problem that Applicant's disclosure addresses facilitates an appreciation that Yamrom's methods and systems are decidedly different from Applicant's claimed subject matter.

Yamrom is directed to a method for modeling an object with a polygonal mesh. In accordance with Yamrom's method, a closed-surface polygonal mesh is obtained and positioned relative to the object that is to be modeled. A ray is then projected through a point-of-interest on the closed-surface polygonal mesh and an intersection point between the ray and a surface of the object is determined. The location of the point-of-interest is adjusted in response to the location of the intersection point, and this is performed for a number of points in the closed-surface polygonal mesh in order to approximate the object.

Exploring this notion in a bit more detail, Yamrom instructs, in column 2 starting at line 31, that its methodology fits a reduced mesh to the surface of an object to approximate the object. If the object is a complex model, the reduced mesh has fewer polygons (e.g. triangles) than the complex model but still accurately represents the surface to be modeled and maintains a predetermined degree of smoothness. Yamrom's approach uses a reduced mesh made up of a closed mesh with a relatively small number of polygons that is placed inside or

outside of an unprocessed complex model containing many thousands of polygons. Points of the reduced mesh are then projected to a projected position to approximate the surface of the complex model. The resulting projection of the reduced mesh has fewer polygons than the complex model, is closed, and approximates the surface of the original, complex model. Yamrom instructs that any holes or irregularities in the original, complex model are sealed and smoothed by the process of projecting the closed, reduced mesh.

For an example of Yamrom's approach, reference is made to Figs. 3, 4 and 5.

Fig. 3 is a flowchart of a general method of modeling a closed surface. At step 10, a reduced mesh having a predetermined number of polygons is positioned relative to the object to be represented by the reduced mesh. The reduced mesh may be positioned inside or outside the object. At step 12, a ray is projected through a point of the mesh (for example, a vertex of a polygon). Fig. 4 illustrates the process of projecting a ray through a point of the reduced mesh. A ray 34 is generated from a start point 30 through point-of-interest 32, which may correspond to a vertex of a polygon 35 in the reduced mesh. The reduced mesh is a closed surface. The intersection of the ray 34 and the surface 36 of the object defines an intersection point 38. Fig. 5 shows a similar projection in which the object is placed inside the reduced mesh. Due to holes in the object, the ray 34 may not intersect the surface 36. At step 14, it is determined whether ray 34 intersects surface 36. If so, flow proceeds to step 16 where the location of the intersection point 38 is used to determine a projected position of the reduced mesh point 32. In some instances, the projected position of point 32 will be the

intersection point 38. The projected position can also be distanced from the surface 36 of the object and still provide a good approximation of the object. If at step 14, it is determined that the ray 34 does not intersect surface 36, then flow proceeds to step 18 where the projected position is determined based on a reference distance. Both steps 16 and 18 proceed to step 20 where the process ends if all points are processed. If not, step 22 locates the next point for processing.

1. Claims 1-22, 24-33, and 35-56

Claim 1

Claim 1 recites a method for determining which shapes are intersected by a ray in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes each characterized by characteristic data. The method recites:

- defining a reference object relative to the represented object;
- determining the positions of the shapes relative to the reference object using the characteristic data; and
- determining, on the basis of the positions of the shapes relative to the reference object, ***those shapes that have no chance of intersecting the ray***, and ***those remaining shapes that <u>may</u> intersect the ray***.

In making out the rejection of this claim, the Office argues that its subject matter is anticipated by Yamrom. In making out the rejection, the Office makes a number of interpretations with respect to Applicant's claim terminology and Yamrom's disclosure. Applicant has tried to follow the Office's interpretation of Yamrom and its application to the claimed subject matter, but cannot follow the logic that the Office uses. To the extent that Applicant understands the Office's

interpretation of Yamrom, Applicant disagrees with the Office's interpretation and application of this reference.

Applicant has studied Yamrom in detail and submits that claim 1 recites subject matter that is neither anticipated by nor rendered obvious in view of Yamrom. For example, this claim recites an act of "determining, on the basis of the positions of the shapes (i.e. the previously-recited collection of predetermined shapes which the Office equates to Yamrom's polygon mesh) relative to the reference object, those shapes that have ***no chance of intersecting the ray***, and ***those remaining shapes that <u>may</u> intersect the ray***." (emphasis added).

The Office appears to equate this subject matter to Yamrom's methodology as described in Fig. 3's steps 14-20. Yamrom's methodology does not determine shapes that have <u>no chance of intersecting the ray</u> and remaining shapes that <u>may</u> intersect the ray. Rather, Yamrom determines whether its ray intersects an object's surface 36 (Fig. 4). If it does, then a point on its reduced mesh is adjusted in response to the intersection point. If the ray does not intersect the object's surface 36, then the point on the reduced mesh is adjusted a reference distance. Yamrom's method then moves on to other points on other shapes of the reduced mesh and presumably other rays that are cast through points of interest relative to the reduced mesh.

Nowhere does Yamrom, in casting its ray through a point of interest 32 on a polygon 35 of the reduced mesh to intersect a surface of a complex object, ascertain any shapes that "have no chance of intersecting the ray, and those remaining shapes that may intersect the ray." Rather, the analysis that Yamrom performs responsive to its cast ray is that which is concerned only with the point

of intersection 38, if one exists. There is no analysis or concern for shapes that have no chance of intersecting the ray, and those remaining shapes that may intersect the ray.

The Office argues in the present Office Action, citing to Yamrom, that "due to holes (Examiner's interpretation: the basis of the positions of the shapes relative to the reference) in the object, the ray 34 may not intersect the surface 36. Applicant respectfully submits that whether Yamrom's ray *may not* intersect surface 36 has nothing whatsoever to do with, as this claim recites, "determining, on the basis of the positions of the shapes relative to the reference object, those shapes that have ***no chance*** of intersecting the ray, and those remaining shapes that ***may*** intersect the ray."

An example from Applicant's specification should be useful at this point to illustrate subject matter that is within the purview of this claim. The example is taken from page 15, line 19 through page 16, line 24, which is reproduced below in its entirety for the convenience of the Office:

> **Example**
>
> As a further example, consider Figs. 7-10. Fig. 7 shows a collection of shapes 400 that comprise a triangle mesh approximating an object of interest. Although this example is described in the context of a triangle mesh, it will be apparent to those of skill in the art, that the evaluation described just below can be conducted in connection with other topologies, examples of which are given above. In this particular example, the collection constitutes 60 surfaces (each triangle comprising one surface) and 42 vertices. In the past, intersection algorithms have evaluated each of the separate triangles of the illustrated collection to determine whether there is an intersection with a cast ray. So, in this case, conventional methods might have started with the first triangle in the first column, evaluated it for an intersection, and then discarded it when there was no intersection. This method would then step through each of the triangles, similarly evaluating them for an intersection with the ray. With complex surfaces having a high

> degree of resolution (i.e. many shapes), processing overhead can be quite large. Advantageously, the described embodiment reduces the number of shapes that must be tested for an intersection. This saves greatly on processing overhead and increases the speed with which objects are processed.
>
> Fig. 7 shows a ray that has been cast toward the object that is approximated by collection 400. The ray extends into and out of the plane of the page upon which Fig. 7 appears. Fig. 8 shows a plane containing the ray that is perpendicular to the page upon which Figures 7 and 8 appear. Fig. 9 shows a sub-set of shapes (shaded for clarity) that might be intersected by the ray. Here, an evaluation has been performed to determine whether the triangle(s) that are defined by the individual vertices straddle the defined plane. If they do straddle the defined plane, then it is possible that they are intersected by the ray. Here, the number of triangles that have to be evaluated by an intersection algorithm have been reduced from 60 to 10.
>
> Fig. 10 shows collection 400 after the intersection algorithm has been run on all of the triangles in the shaded sub-set of Fig. 9. In this example, only one triangle (shaded for clarity) is intersected by the ray.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of claim 1 does not meet this standard.

As there is not even a mention in Yamrom of "determining, on the basis of the positions of the shapes relative to the reference object, those shapes that have ***no chance*** of intersecting the ray, and those remaining shapes that ***may*** intersect the ray", Applicant respectfully submits that the standard for anticipation under 35 U.S.C. §102 is not satisfied by Yamrom with respect to claim 1. Accordingly, this claim is allowable.

Claim 2

Claim 2 depends from claim 1 and further recites "using a predetermined algorithm to determine which one of those remaining shapes intersects the ray." In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in column 7, lines 6-35 which, as argued by the Office, illustrates a cylindrical projection algorithm. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly disclose using a predetermined algorithm to determine which of those "remaining shapes" intersects the ray.

Accordingly, for at least this reason, this claim is allowable.

Claim 3

Claim 3 depends from claim 1 and recites that the collection of shapes comprises at least one polygonal shape.

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 2 and 10. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly

disclose using collection of shapes comprising at least one polygonal shape, in this particular context.

Accordingly, for at least this reason, this claim is allowable.

Claim 4

Claim 4 depends from claim 1 and recites that the collection of shapes comprises a plurality of polygonal shapes.

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 2 and 10. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly disclose using collection of shapes comprising a plurality of polygonal shapes, in this particular context.

Accordingly, for at least this reason, this claim is allowable.

Claim 5

Claim 5 depends from claim 1 and recites that the collection of shapes comprises at least one triangle.

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 2 and 10. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly disclose using collection of shapes comprising at least one triangle, in this particular context.

Accordingly, for at least this reason, this claim is allowable.

Claim 6

Claim 6 depends from claim 1 and recites that the collection of shapes comprises a plurality of triangles.

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 2 and 10. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly disclose using collection of shapes comprising a plurality of triangles, in this particular context.

Accordingly, for at least this reason, this claim is allowable.

Claim 7

Claim 7 depends from claim 1 and recites that the collection of shapes comprises a triangle mesh.

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 2 and 10. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly disclose using collection of shapes comprising a triangle mesh, in this particular context.

Accordingly, for at least this reason, this claim is allowable.

Claim 8

Claim 8 depends from claim 1 and recites that the collection of shapes comprises a triangle strip.

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 2 and 10. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly disclose using collection of shapes comprising a triangle strip, in this particular context.

Accordingly, for at least this reason, this claim is allowable.

Claim 9

Claim 9 depends from claim 1 and recites that the collection of shapes comprises a triangle fan.

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 2 and 10. Applicant respectfully disagrees and submits that this claim is not anticipated by Yamrom.

More specifically, Applicant respectfully submits that Yamrom neither discloses nor suggests a methodology that determines "those remaining shapes that may intersect the ray" as recited in claim 1. Given this, Yamrom cannot possibly disclose using collection of shapes comprising a triangle fan, in this particular context.

Accordingly, for at least this reason, this claim is allowable.

Claim 10

Claim 10 depends from claim 1 and recites that the "reference object comprises at least one plane". In making out this rejection, the Office refers to Yamrom's Figs. 4 and 5, as well as Yamrom's column 1, lines 50-52. The Office then argues that as follows:

> "the step of the reference object comprises a plane is inherent because in order to establish a model (or approximation) of an object, one must define the X, Y and Z planes parameter. That would be the same as the ray X and Y planes. In this case the plane becomes parallel to one of the x, y and z-axes."

Applicant respectfully submits that it is puzzled by this argument. This argument is problematic for a number of different reasons. First, the argument does not appreciate, nor does it even attempt to understand this claim's subject

matter in the context of claim 1. For example, substituting this claim's subject matter in claim 1 (i.e. substituting "at least one plane" for "reference object"), one is left with the following recitation:

- defining [a reference object] ***at least one plane*** relative to the represented object;
- determining the positions of the shapes relative to the [a reference object] ***at least one plane*** using the characteristic data; and
- determining, on the basis of the positions of the shapes relative to the [a reference object] ***at least one plane***, those shapes that have no chance of intersecting the ray, and those remaining shapes that may intersect the ray.

Applicant respectfully submits that the Office's argument is misplaced and, to the extent it is understood, simply does not make sense. For example, Yamrom's column 1, lines 50-52 state as follows:

> "The projecting is performed for a plurality of points in the closed-surface polygonal mesh in order to approximate the object."

This excerpt has nothing whatsoever to do with a plane, as contemplated in this claim.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of claim 10 falls far short of meeting this standard.

<u>Claim 11</u>

Claim 11 depends from claim 1 and recites that the "reference object comprises a plurality of planes". In making out this rejection, the Office refers to Yamrom's Figs. 4 and 5, as well as Yamrom's column 1, lines 50-52. The Office then argues that as follows:

> "the step of the reference object comprises a plane is inherent because in order to establish a model (or approximation) of an object, one must define the X, Y and Z planes parameter. That would be the same as the ray X and Y planes. In this case the plane becomes parallel to one of the x, y and z-axes."

As noted above, Applicant is puzzled by this argument. This argument is problematic for a number of different reasons. First, the argument does not appreciate, nor does it even attempt to understand this claim's subject matter in the context of claim 1.

Applicant respectfully submits that the Office's argument is misplaced and, to the extent it is understood, simply does not make sense. For example, Yamrom's column 1, lines 50-52 state as follows:

> "The projecting is performed for a plurality of points in the closed-surface polygonal mesh in order to approximate the object."

This excerpt has nothing whatsoever to do with a plurality of planes, as contemplated in this claim.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*,

814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of claim 11 falls far short of meeting this standard.

Claim 12

Claim 12 depends from claim 1 and recites that "determining the positions of the shapes comprises determining positional aspects of sub-components of individual ones of the shapes to provide the characteristic data."

In making out the rejection of this claim, the Office argues that Yamrom anticipates its subject matter in Figs. 3-5 and in column 2, lines 31-47. Specifically, the Office argues that Yamrom teaches, in column 2, lines 31-47 "the positions of the vertices relative to the reference object."

The excerpt of Yamrom relied on by the Office is reproduced below for the convenience of the Office:

> The present invention fits a reduced mesh to the surface of an object to approximate the object. If the object is a complex model, the reduced mesh has fewer polygons (e.g. triangles) than the complex model but still accurately represents the surface to be modeled and maintains a predetermined degree of smoothness. The invention uses a reduced mesh made up of a closed mesh with a relatively small number of polygons that is placed inside or outside of an unprocessed complex model containing many thousands of polygons. Points of the reduced mesh are then projected to a projected position to approximate the surface of the complex model. The resulting projection of the reduced mesh has fewer polygons than the complex model, is closed, and approximates the surface of the original, complex model. As described herein, any holes or irregularities in the original, complex model are sealed and smoothed by the process of projecting the closed, reduced mesh.

The Office's argument with regards to the rejection of this claim appears to have been made in a vacuum without any appreciation of the context of how this claim relates to claim 1 from which it depends. Once again, moving the material in this claim into claim 1 provides the following claim:

> In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes each characterized by characteristic data, a method for determining which of the shapes are intersected by the ray, the method comprising:
>
> defining a reference object relative to the represented object;
>
> determining the positions of the shapes relative to the reference object using the characteristic data, wherein ***determining the positions of the shapes comprises determining positional aspects of sub-components of individual ones of the shapes to provide the characteristic data***; and
>
> determining, on the basis of the positions of the shapes relative to the reference object, those shapes that have no chance of intersecting the ray, and those remaining shapes that may intersect the ray.

Even a cursory comparison of this claim with Yamrom's excerpt provided above should indicate that this claim is not anticipated.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of claim 12 does not meet this standard.

Thus, for at least these reasons, Applicant respectfully submits that claim 12 is allowable over Yamrom.

<u>Claim 13</u>

Claim 13 depends from claim 12 and recites that "the individual shapes comprise polygons and the sub-components comprise vertices that define the polygons, said determining the positions of the shapes comprising computing the positions of the vertices relative to the reference object."

Given that claim 12 is not anticipated by Yamrom, and that claim 1 is not anticipated by Yamrom, claim 13 is not anticipated by Yamrom. Accordingly, for at least this reason, this claim is allowable.

<u>Claim 14</u>

Claim 14 depends from claim 13 and recites that "the reference object comprises a plane." Given claims 13, 12 and 1 are not anticipated by Yamrom, this claim is not anticipated by Yamrom and hence, is allowable. In addition, the Office utilizes the same logic as was used in making out the rejection of claims 10 and 11. Accordingly, for all of the reasons set forth above with respect to the Office's argument being faulty, this claim is allowable.

<u>Claim 15</u>

Claim 15 depends from claim 14 and recites that the "plane is parallel to one of the x, y, and z axes." Given that claims 14, 13, 12 and 1 are not anticipated by Yamrom, this claim is not anticipated by Yamrom and hence, is allowable. In addition, the Office utilizes the same logic as was used in making out the rejection of claims 10 and 11. Accordingly, for all of the reasons set forth above with respect to the Office's argument being faulty, this claim is allowable.

Claim 16

Claim 16 recites a method for determining which of a collection of pre-determined shapes are intersected by a ray cast toward an object that is represented by the shapes. The method recites:

- defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;
- casting a ray toward the approximated object;
- defining a reference object relative to the collection of polygons and that contains the cast ray;
- pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object; and
- using the characteristic data to ascertain the positions of the individual polygons relative to the reference object.

In making out the rejection of this claim, the Office argues that Yamrom anticipates this claim's subject matter. Specifically, the Office first cites to Yamrom's Abstract and appears to loosely argue that the Yamrom's Abstract section anticipates this claim. In addition, the Office cites to Yamrom's Figs. 3 and 5 and steps 14, 16, 18, and 22 in apparent support for its rejection and, interestingly, argues features that do not appear in this claim.

Applicant has reviewed the excerpts cited by the Office and respectfully submits that these excerpts do not anticipate or even remotely suggest the subject matter of this claim.

For example, this claim recites "defining a reference object relative to the collection of polygons and that contains the cast ray...." Applicant's Figs. 3 and 8

provide but one example of subject matter that is covered by this claim. Nowhere can Applicant find this recited claim feature in Yamrom.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of this claim does not meet this standard. Accordingly, for at least this reason, this claim is allowable.

Claim 17

Claim 17 depends from claim 16 and recites that the collection of polygons approximate the surface of the object. In making out this rejection, the Office cites to Yamrom's Fig. 2. In view of the fact that claim 16 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 18

Claim 18 depends from claim 16 and recites that the individual polygons have a similar geometry. In making out this rejection, the Office cites to Yamrom's Fig. 2. In view of the fact that claim 16 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 19

Claim 19 depends from claim 16 and recites that the individual polygons comprise triangles. In making out this rejection, the Office cites to Yamrom's Fig.

2. In view of the fact that claim 16 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 20

Claim 20 depends from claim 16 and recites that the "collection of polygons has a plurality of faces and a plurality of vertices, said faces outnumbering said vertices." In making out this rejection, the Office cites to Yamrom's Fig. 2. In view of the fact that claim 16 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 21

Claim 21 depends from claim 16 and recites that at least two of the polygons share at least one side. In making out this rejection, the Office cites to Yamrom's Fig. 2. In view of the fact that claim 16 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 22

Claim 22 depends from claim 16 and recites that at least two of the polygons share at least one vertex. In making out this rejection, the Office cites to Yamrom's Fig. 2. In view of the fact that claim 16 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 24

Claim 24 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

- defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;
- casting a ray toward the approximated object;
- ***defining a reference object relative to the collection of polygons and that contains the cast ray;***
- pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object; and
- using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set of polygons that might be intersected by the ray.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above in its rejection of claim 16. Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines a reference object relative to the collection of polygons and that contains the cast ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully

submits that the rejection of this claim does not meet this standard. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

Claim 25

Claim 25 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

- defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;
- casting a ray toward the approximated object;
- defining a reference object relative to the collection of polygons and that contains the cast ray;
- pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object; and
- using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set of polygons at least some of which straddle the reference object.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above in its rejection of claim 16. Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines a reference object relative to the collection of polygons and that contains the cast ray. As Yamrom neither discloses nor suggests the subject

matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of this claim does not meet this standard. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

Claim 26

Claim 26 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

- defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;
- casting a ray toward the approximated object;
- defining a reference object relative to the collection of polygons and that contains the cast ray;
- pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object;
- using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set of polygons at least some of which straddle the reference object; and
- evaluating the sub-set of polygons to determine which polygons are intersected by the ray.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above in its rejection of claim 16. Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines a reference object relative to the collection of polygons and that contains the cast ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of this claim does not meet this standard. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

<u>Claim 27</u>

Claim 27 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

- defining a plurality of triangles that approximate an object, individual triangles having three vertices;
- casting a ray toward the approximated object;

- defining at least one plane relative to the approximated object to contain the ray;
- pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane; and
- using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above in its rejection of claim 16. Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines a plane relative to the approximated object to contain the ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of this claim does not meet this standard. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

Claim 28

Claim 28 depends from claim 27 and recites that the defining of the plurality of triangles comprises defining a triangle mesh. In making out this rejection, the Office cites to Yamrom's Fig. 2. In view of the fact that claim 27 is

not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 29

Claim 29 depends from claim 27 and recites that the defining of the plurality of triangles comprises defining a triangle fan. In making out this rejection, the Office cites to Yamrom's Figs. 2 and 3. In view of the fact that claim 27 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 30

Claim 30 depends from claim 27 and recites that the defining of the plurality of triangles comprises defining a triangle strip. In making out this rejection, the Office cites to Yamrom's Figs. 2 and 3. In view of the fact that claim 27 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 31

Claim 31 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

- defining a plurality of triangles that approximate an object, individual triangles having three vertices;
- casting a ray toward the approximated object;

- ***defining at least one plane relative to the approximated object to contain the ray;***
- pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane; and
- using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises determining whether a particular individual triangle has a chance of being intersected by the ray.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above in its rejection of claim 16. Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines at least one plane relative to the approximated to contain the ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of this claim does not meet this standard. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

<u>Claim 32</u>

Claim 32 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a

method for determining which of the shapes are intersected by the ray, the method comprising:

- defining a plurality of triangles that approximate an object, individual triangles having three vertices;
- casting a ray toward the approximated object;
- ***defining at least one plane relative to the approximated object to contain the ray;***
- pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane; and
- using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises determining whether a particular individual triangle straddles said at least one plane.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above. Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines at least one plane relative to the approximated to contain the ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of this claim does not meet this standard. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

Claim 33

Claim 33 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

- defining a plurality of triangles that approximate an object, individual triangles having three vertices;
- casting a ray toward the approximated object;
- ***defining at least one plane relative to the approximated object to contain the ray;***
- pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane;
- using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises defining a sub-set of triangles at least some of which straddle the plane; and
- evaluating the sub-set of triangles to ascertain which triangles are intersected by the ray.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above in its rejection of claim 16. Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines at least one plane relative to the approximated to contain the ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully

submits that the rejection of this claim does not meet this standard. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

Claim 35

Claim 35 depends from claim 27 and recites that all of the triangles share at least one vertex with another of the triangles. In making out this rejection, the Office cites to Yamrom's Fig. 2. In view of the fact that claim 27 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 36

Claim 36 depends from claim 27 and recites that the defining of "said at least one plane comprises defining a plane to be parallel to one of the x, y, or z axes. In making out this rejection, the Office argues that Yamrom inherently discloses this feature because in order to establish a model of an object, one must define the x, y, and z planes parameters. The Office continues and states "[t]hat would be the same as the ray in the x and y planes. In this case the plane becomes parallel to one of the x, y, and z-axes."

Applicant respectfully submits that it is puzzled by this reasoning. Applicant respectfully submits that this rejection simply makes no sense at all and completely disregards the context of this claim's subject matter when viewed in light of its independent claim.

This claim is not anticipated by Yamrom and is allowable.

Claim 37

Claim 37 recites a method for determining which of a number of polygons that represent an object are intersected by a ray that is cast at the object. The method recites:

- defining a sub-set of polygons from a collection of polygons that approximate an object by determining which polygons have vertices that satisfy a predefined relationship relative to a reference object; and
- evaluating the sub-set of polygons to ascertain which of the polygons is intersected by a cast ray.

In making out the rejection of this claim, the Office cites to Yamrom's abstract section and to Figs. 3-5 and makes arguments similar to those made above. Specifically, the Office first cites to Yamrom's Abstract and appears to loosely argue that the Yamrom's Abstract section anticipates this claim. In addition, the Office cites to Yamrom's Figs. 3 and 5 and steps 14, 16, 18, and 22 in apparent support for its rejection and, interestingly, argues features that do not appear in this claim.

Applicant has reviewed the excerpts cited by the Office and respectfully submits that these excerpts do not anticipate or even remotely suggest the subject matter of this claim.

Specifically, Applicant can find no disclosure in which a sub-set of polygons is defined from a collection of polygons that approximate an object ***by determining which polygons have vertices that satisfy a predefined relationship relative to a reference object***, which set-set is evaluated to ascertain which of the polygons is intersected by a cast ray.

Yamrom simply does not appear to disclose any such method. In addition, those excerpts of Yamrom relied on by the Office do not appear to be germane to the features recited in this claim. Yamrom neither discloses nor suggests the subject matter of this claim. Accordingly, this claim is allowable.

<u>Claim 38</u>

Claim 38 depends from claim 37 and recites that the reference object comprises a plane. In making out the rejection of this claim, the Office cites to Yamrom's Figs. 4 and 5, and also to column 1, lines 50-52.

Applicant has reviewed Figs. 4 and 5 and can find no plane as contemplated in this claim. In addition, Yamrom's column 1, lines 50-52 simply states as follows:

> "The projecting is performed for a plurality of points in the closed-surface polygonal mesh in order to approximate the object."

This excerpt makes no mention whatsoever of a plane. Applicant is simply at a loss to understand to the Office's rejection. Notwithstanding the Office's articulation of this rejection, Applicant has reviewed this reference in detail and can find no disclosure or suggestion of this claim's subject matter. Accordingly, this claim is allowable.

<u>Claim 39</u>

Claim 39 depends from claim 37 and recites that the reference object comprises multiple planes. In making out the rejection of this claim, the Office cites to Yamrom's Figs. 4 and 5, and also to column 1, lines 50-52.

Applicant has reviewed Figs. 4 and 5 and can not find even a single plane, let alone multiple planes as contemplated in this claim. In addition, Yamrom's column 1, lines 50-52 simply states as follows:

> "The projecting is performed for a plurality of points in the closed-surface polygonal mesh in order to approximate the object."

This excerpt makes no mention whatsoever of a plane. Applicant is simply at a loss to understand to the Office's rejection. Notwithstanding the Office's articulation of this rejection, Applicant has reviewed this reference in detail and can find no disclosure or suggestion of this claim's subject matter. Accordingly, this claim is allowable.

Claim 40

Claim 40 recites in a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined polygons, a method for determining which of the polygons are intersected by the ray, the method comprising:

- defining a sub-set of polygons from a collection of polygons that approximate an object by determining which polygons have vertices that satisfy a predefined relationship relative to a reference object, wherein the reference object comprises a plane; and
- evaluating the sub-set of polygons to ascertain which of the polygons is intersected by a cast ray,

- wherein said determining comprises determining which polygons straddle the plane.

In making out the rejection of this claim, the Office cites to Yamrom's abstract section and to Figs. 3-5 and makes arguments similar to those made above. In fact, the Office appears to use some of the same claim terminology that appears in other claims and not in this claim, in making out the rejection of this claim.

Because the Office does not specifically apply Yamrom to the specific claim elements in this claim, Applicant is a bit unclear of the Office's official position with respect to this reference and how it purportedly anticipates this claim's subject matter. Nonetheless, Applicant has studied Yamrom and can find no disclosure or suggestion of this claim's subject matter. Specifically, this claim recites "defining a sub-set of polygons from a collection of polygons that approximate an object by determining which polygons have vertices that satisfy a predefined relationship relative to a reference object." Yamrom does not appear to disclose any such method in which a sub-set of polygons is defined by determining which polygons from a collection of polygons have vertices that satisfy a predefined relationship relative to a reference object. As Yamrom neither discloses nor suggests any such subject matter, it is virtually impossible for Yamrom to disclose or suggest the subject matter of the second- and third-recited claim elements which rely on the first-recited claim element.

MPEP §2131 states that, "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference," *Verdegaal Bros. v. Union Oil Co. of California*,

814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Applicant respectfully submits that the rejection of this claim does not meet this standard.

Claims 41 and 42

Claims 41 and 42 depend from claim 40 and recite, respectively, computer-readable media with instructions that implement claim 37's method, and a programmable computer having software code that can execute to implement claim 37's method. As claim 37 is not anticipated and is allowable, this claims are allowable as depending on an allowable base claim.

Claim 43

Claim 43 recites a computer graphic processing system comprising a programmable computer programmed with computer-readable instructions which, when executed by the programmable computer, implement the following method:

- defining a plurality of polygons that approximate an object, individual polygons having a plurality of vertices;
- casting a ray toward the approximated object;
- ***defining at least one plane relative to the approximated object to contain the ray;***
- pre-characterizing the vertices of the plurality of polygons to provide characteristic data that describes the positions of the vertices relative to said at least one plane;
- using the characteristic data to ascertain the positions of the individual polygons relative to said at least one plane;
- determining which of the individual polygons might be intersected by the ray, based upon their ascertained positions, to provide a sub-set of polygons; and
- evaluating the sub-set of polygons to ascertain which of the polygons are intersected by the ray.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above in relation to other of the claim rejections. In fact, the Office continues to ignore the specifically recited claim features in making out this claim's rejection.

Notwithstanding, Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines at least one plane relative to the approximated to contain the ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

<u>Claim 44</u>

Claim 44 depends from claim 43 and recites that the defining of the plurality of polygons comprises defining a polygon mesh. In making out this rejection, the Office cites to Yamrom's Figs. 2 and 3. In view of the fact that claim 43 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

<u>Claim 45</u>

Claim 45 depends from claim 43 and recites that the defining of the plurality of polygons comprises defining a polygon fan. In making out this rejection, the Office cites to Yamrom's Figs. 2 and 3. In view of the fact that

claim 43 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 46

Claim 46 depends from claim 43 and recites that the defining of the plurality of polygons comprises defining a polygon strip. In making out this rejection, the Office cites to Yamrom's Figs. 2 and 3. In view of the fact that claim 43 is not anticipated by Yamrom, this claim is not anticipated by Yamrom and is, accordingly, allowable.

Claim 47

Claim 47 depends from claim 43 and recites that the defining of the at least one plane comprises defining said plane to be parallel to one of the x, y, and z axes. In making out this rejection, the Office argues that Yamrom inherently discloses this feature because in order to establish a model of an object, one must define the x, y, and z planes parameters. The Office continues and states "[t]hat would be the same as the ray in the x and y planes. In this case the plane becomes parallel to one of the x, y, and z-axes."

Applicant respectfully submits that it is puzzled by this reasoning. Applicant respectfully submits that this rejection simply makes no sense at all and completely disregards the context of this claim's subject matter when viewed in light of its independent claim.

This claim is not anticipated by Yamrom and is allowable.

Claim 48

Claim 48 recites one or more computer-readable media having computer-readable instructions thereon which, when executed by a computer graphic processing system, implement the following method:

- defining a plurality of triangles that approximate an object, individual triangles having three vertices;
- casting a ray toward the approximated object;
- ***defining at least one plane relative to the approximated object to contain the ray;***
- pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane;
- using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane;
- determining which of the individual triangles might be intersected by the ray, based upon their ascertained positions, to provide a sub-set of triangles; and
- evaluating the sub-set of triangles to ascertain which of the triangles are intersected by the ray.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above. In fact, the Office continues to ignore the specifically-recited claim features in making out the rejection of this claim.

Applicant has studied Yamrom in detail and can find no disclosure or suggestion that Yamrom defines at least one plane relative to the approximated to contain the ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element, it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act. Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

Claim 49

Claim 49 depends from claim 48 and recites that the defining of the plurality of triangles comprises defining one of a triangle mesh, a triangle strip and a triangle fan. In making out the rejection of this claim, the Office cites to Yamrom's Figs. 2 and 3. As claim 48 is not anticipated by Yamrom, neither is this claim. Accordingly, this claim is allowable.

Claim 50

Claim 50 recites a computer graphic processing system comprising:

- a processor;
- memory; and
- software code stored in the memory that causes the processor to implement a ray-intersection algorithm which:
    - casts a ray at a collection of shapes that approximate an object;
    - ***defines a reference object that contains the ray***;
    - pre-characterizes aspects of individual ones of the shapes of the collection to provide characteristic data; and
    - uses the characteristic data to ascertain the position of the shapes of the collection of shapes relative to the reference object.

In making out the rejection of this claim, the Office uses and characterizes Yamrom in much the same way as it did above. Applicant has studied Yamrom in detail and can find no disclosure or suggestion in Yamrom that defines a reference object that contains the recited ray. As Yamrom neither discloses nor suggests the subject matter recited in this claim element, it is virtually impossible for Yamrom to disclose or suggest the recited acts that follow and rely upon this act.

Accordingly, this claim is allowable as it is neither anticipated by nor rendered obvious in view of Yamrom.

Claim 51

Claim 51 depends from claim 50 and recites that the ray intersection algorithm casts a ray at a collection of polygons and that each of the polygons has a similar geometry.

As claim 50 is not anticipated by Yamrom, neither is this claim. Accordingly, this claim is allowable.

Claim 52

Claim 52 depends from claim 50 and recites that the ray intersection algorithm casts a ray at a collection of triangles.

As claim 50 is not anticipated by Yamrom, neither is this claim. Accordingly, this claim is allowable.

Claim 53

Claim 53 depends from claim 52 and recites that the collection of triangles defines a triangle mesh.

As claims 50 and 52 are not anticipated by Yamrom, neither is this claim. Accordingly, this claim is allowable.

Claim 54

Claim 54 depends from claim 50 and recites that the ray intersection algorithm pre-characterizes aspects of the shapes by computing positions of various sub-components of the shapes relative to the reference object.

As claim 50 is not anticipated by Yamrom, neither is this claim. Accordingly, this claim is allowable.

Claim 55

Claim 55 depends from claim 54 and recites that the reference object comprises at least one plane.

As claims 54 and 50 are not anticipated by Yamrom, neither is this claim. Accordingly, this claim is allowable.

Claim 56

Claim 56 depends from claim 55 and recites that the shapes comprise polygons and the sub-components comprise vertices of the polygons.

As claims 55, 54 and 50 are not anticipated by Yamrom, neither is this claim. Accordingly, this claim is allowable.

B. Rejection under 35 U.S.C. §112, first paragraph

Claims 23 and 34 stand rejected under 35 U.S.C. §112, first paragraph, as being based on a disclosure which is not enabling. In making out this rejection, the Office states that the claim language does not have any logical meaning, because it is not clear whether the invention uses a single polygon or a plurality of polygons. The Office goes on to pose the following question:

How does the approximation of an object detected with only one polygon?;

Claims 23 and 34

Claim 23 depends from claim 16. Claim 16 recites "[i]n a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising [emphasis added]:

- defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;
- casting a ray toward the approximated object;
- defining a reference object relative to the collection of polygons and that contains the cast ray;
- pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object; and
- using the characteristic data to ascertain the positions of the individual polygons relative to the reference object."

Claim 34 depends from claim 27. Claim 27 recites "[i]n a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising [emphasis added]:

- defining a plurality of ***triangles*** that approximate an object, individual triangles having three ***vertices***;
- casting a ray toward the approximated object;
- defining at least one plane relative to the approximated object to contain the ray;

- pre-characterizing the ***vertices*** of the plurality of ***triangles*** to provide characteristic data that describes the positions of the ***vertices*** relative to said at least one plane; and
- using the characteristic data to ascertain the positions of the individual ***triangles*** relative to said at least one plane."

Claim 34 recites "wherein none of the triangles share any vertices."

Claim 23 recites "wherein none of said polygons share a vertex." The Office is in an apparent quandary because the Office apparently does not understand whether this claim refers to a single polygon or a plurality of polygons. Applicant respectfully submits that it is abundantly clear from the context of claim 23, in light of its independent claim 16, that claim 23 refers to "said polygons", where "said polygons" are, in turn, those polygons that are referenced in claim 16. Turning attention to claim 16, "said polygons" refers to the "collection of polygons." Therefore, claim 16 refers to a plurality of polygons. This fact should answer the above question posed by the Office above. In addition, Applicant gave an example of subject matter that would be covered by this claim in its paper entitled "Response to Office Action Dated December 26, 2002", previously filed with the Office.

Applicant does not understand the Office's confusion or the Office's articulation of this rejection. Particularly, the Office states, in making out this rejection, that the "claim languages are not following the specification languages."

Throughout Applicant's specification, various embodiments are discussed in terms of polygons and collections of polygons. The specification states that triangles constitute an example of such polygons. As an example, consider page 10, lines 1-9 set forth below:

> As shown, a collection of shapes is first defined to approximate an object in connection with a computer graphics program. In this example, the surface of the object is approximated by a collection of shapes. Fig. 3 shows an exemplary portion of such a collection generally at 300. Any suitable shapes can be used. In the described embodiment, the shapes have a similar geometry. ***Typically, polygons having a plurality of vertices are used.*** As will become apparent below, it is advantageous to select polygons that collectively have more faces than vertices when approximating the surface of an object. ***<u>In the illustrated example</u>, the polygons comprise triangles.***

Applicant simply does not understand why the Office does not understand that the claim language is indeed following the language of the specification. The specification introduces the notion of using polygons to approximate an object, and then introduces the notion that one example of such a polygon is a triangle.

Applicant respectfully submits that there is nothing non-enabling about the subject matter of these claims.

The enablement and written description requirements are set forth in the patent statute at 35 U.S.C. § 112 ¶ 1. To be enabling, the specification of the patent must teach those skilled in the art how to make and use the full scope of the claimed invention without "undue experimentation." *Plant Genetic Systems v. DeKalb Genetics Corp.*, 315 F.3d 1335, 1339 (Fed. Cir. 2003).

The Federal Circuit set forth a number of factors that a court may consider in determining whether a disclosure would require undue experimentation in the ex parte prosecution case *In re Wands*, 858 F.2d 731, 737 (Fed. Cir. 1988): (1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims.

Applicant respectfully submits that, in view of the teachings in its Specification (item 2), little or no experimentation would be required (item 6) and that, given the level of skill in the art (item 6), one of skill in the art would know how to make and use the claimed subject matter.

Consider first the instruction that appears on page 10, lines 10-22, which is reproduced below:

> As shown in Fig. 3, there are four depicted triangles, 302, 304, 306, and 308 having the vertices V1-V7 as indicated. There can be many thousands of triangles used to approximate the surface of an object. Additionally, the collection of triangles can be arranged to have different topologies. Exemplary topologies are shown in Figs. 4-6. Specifically, Fig. 4 shows a topology known as a triangle mesh; Fig. 5 shows a topology known as a triangle strip; and Fig. 6 shows a topology known as a triangle fan. The collection of triangles can be arranged so that some of them share a side and/or vertices. For example, in Fig. 3, triangles 302 and 304 share a vertex, while triangles 304 and 306 share a side and two vertices. ***Other collections can be defined where none of the triangles share a vertex.*** Although triangles are depicted in the illustrated and described embodiment, it is to be understood that other shapes or polygons can be used to approximate an object.

The Specification then goes on to instruct from page 10, line 23 through page 15, line 17 how one embodiment's methodology operates. Applicant respectfully submits that there is nothing non-enabling about this disclosure with regards to both claims 23 and 34.

The language employed in a claim must always be analyzed in light of the specification. *In re Mayhew*, 527 F.2d 1229 (CCPA 1976). When claims 23 and 34 are considered in light of this Specification, Applicant respectfully submits that the claims are enabled.

Conclusion

Applicant respectfully submits that all of the Office's rejections have been traversed. As such, Applicant respectfully submits that all of the claims are in condition for allowance.

Respectfully Submitted,

Dated: 12/16/04

By:
Lance R. Sadler
Lee & Hayes, PLLC
Reg. No. 38,605
(509) 324-9256 ext. 226

(8) Appendix of Appealed Claims

1. (Original) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes each characterized by characteristic data, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a reference object relative to the represented object;

determining the positions of the shapes relative to the reference object using the characteristic data; and

determining, on the basis of the positions of the shapes relative to the reference object, those shapes that have no chance of intersecting the ray, and those remaining shapes that may intersect the ray.

2. (Original) The method of claim 1 further comprising using a predetermined algorithm to determine which one of those remaining shapes intersects the ray.

3. (Original) The method of claim 1, wherein the collection of shapes comprises at least one polygonal shape.

4. (Original) The method of claim 1, wherein the collection of shapes comprises a plurality of polygonal shapes.

5. (Original) The method of claim 1, wherein the collection of shapes comprises at least one triangle.

6. (Original) The method of claim 1, wherein the collection of shapes comprises a plurality of triangles.

7. (Original) The method of claim 1, wherein the collection of shapes comprises a triangle mesh.

8. (Original) The method of claim 1, wherein the collection of shapes comprises a triangle strip.

9. (Original) The method of claim 1, wherein the collection of shapes comprises a triangle fan.

10. (Original) The method of claim 1, wherein said reference object comprises at least one plane.

11. (Original) The method of claim 1, wherein said reference object comprises a plurality of planes each of which contain the ray.

12. (Original) The method of claim 1, wherein said determining the positions of the shapes comprises determining positional aspects of sub-components of individual ones of the shapes to provide the characteristic data.

13. (Original) The method of claim 12, wherein the individual shapes comprise polygons and the sub-components comprise vertices that define the polygons, said determining the positions of the shapes comprising computing the positions of the vertices relative to the reference object.

14. (Original) The method of claim 13, wherein the reference object comprises a plane.

15. (Original) The method of claim 14, wherein the plane is parallel to one of the x, y, and z axes.

16. (Original) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;

casting a ray toward the approximated object;

defining a reference object relative to the collection of polygons and that contains the cast ray;

pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object; and

using the characteristic data to ascertain the positions of the individual polygons relative to the reference object.

17. (Original) The method of claim 16, wherein the collection of polygons approximate the surface of the object.

18. (Original) The method of claim 16, wherein the individual polygons have a similar geometry.

19. (Original) The method of claim 16, wherein the individual polygons comprise triangles.

20. (Original) The method of claim 16, wherein the collection of polygons has a plurality of faces and a plurality of vertices, said faces outnumbering said vertices.

21. (Original) The method of claim 16, wherein at least two of said polygons share at least one side.

22. (Original) The method of claim 16, wherein at least two of said polygons share at least one vertex.

23. (Original) The method of claim 16, wherein none of said polygons share a vertex.

24. (Previously Presented) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;

casting a ray toward the approximated object;

defining a reference object relative to the collection of polygons and that contains the cast ray;

pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object; and

using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set of polygons that might be intersected by the ray.

25. (Previously Presented) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;

casting a ray toward the approximated object;

defining a reference object relative to the collection of polygons and that contains the cast ray;

pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object; and

using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set of polygons at least some of which straddle the reference object.

26. (Previously Presented) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a collection of polygons that approximate an object, individual polygons having a plurality of vertices;

casting a ray toward the approximated object;

defining a reference object relative to the collection of polygons and that contains the cast ray;

pre-characterizing at least some vertices of at least some of the polygons to provide characteristic data that describes the vertices' positions relative to the reference object;

using the characteristic data to ascertain the positions of the individual polygons relative to the reference object, wherein said using of the characteristic data comprises determining whether an individual polygon is in a sub-set of polygons at least some of which straddle the reference object; and

evaluating the sub-set of polygons to determine which polygons are intersected by the ray.

27. (Original) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a plurality of triangles that approximate an object, individual triangles having three vertices;

casting a ray toward the approximated object;

defining at least one plane relative to the approximated object to contain the ray;

pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane; and

using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane.

28. (Original) The method of claim 27, wherein said defining of said plurality of triangles comprises defining a triangle mesh.

29. (Original) The method of claim 27, wherein said defining of said plurality of triangles comprises defining a triangle fan.

30. (Original) The method of claim 27, wherein said defining of said plurality of triangles comprises defining a triangle strip.

31. (Previously Presented) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a plurality of triangles that approximate an object, individual triangles having three vertices;

casting a ray toward the approximated object;

defining at least one plane relative to the approximated object to contain the ray;

pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane; and

using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises determining whether a particular individual triangle has a chance of being intersected by the ray.

32. (Previously Presented) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a plurality of triangles that approximate an object, individual triangles having three vertices;

casting a ray toward the approximated object;

defining at least one plane relative to the approximated object to contain the ray;

pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane; and

using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises determining whether a particular individual triangle straddles said at least one plane.

33. (Previously Presented) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined shapes, a method for determining which of the shapes are intersected by the ray, the method comprising:

defining a plurality of triangles that approximate an object, individual triangles having three vertices;

casting a ray toward the approximated object;

defining at least one plane relative to the approximated object to contain the ray;

pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane;

using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane, wherein said using of the characteristic data comprises defining a sub-set of triangles at least some of which straddle the plane; and

evaluating the sub-set of triangles to ascertain which triangles are intersected by the ray.

34. (Original) The method of claim 27, wherein none of the triangles share any vertices.

35. (Original) The method of claim 27, wherein all of the triangles share at least one vertex with another of the triangles.

36. (Original) The method of claim 27, wherein said defining of said at least one plane comprises defining a plane to be parallel to one of the x, y, or z axes.

37. (Original) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined polygons, a

method for determining which of the polygons are intersected by the ray, the method comprising:

defining a sub-set of polygons from a collection of polygons that approximate an object by determining which polygons have vertices that satisfy a predefined relationship relative to a reference object; and

evaluating the sub-set of polygons to ascertain which of the polygons is intersected by a cast ray.

38. (Original) The method of claim 37, wherein the reference object comprises a plane.

39. (Original) The method of claim 37, wherein the reference object comprises multiple planes.

40. (Previously Presented) In a computer graphic processing system in which a ray is cast toward an object represented by a collection of pre-determined polygons, a method for determining which of the polygons are intersected by the ray, the method comprising:

defining a sub-set of polygons from a collection of polygons that approximate an object by determining which polygons have vertices that satisfy a predefined relationship relative to a reference object, wherein the reference object comprises a plane; and

evaluating the sub-set of polygons to ascertain which of the polygons is intersected by a cast ray,

wherein said determining comprises determining which polygons straddle the plane.

41. (Original) One or more computer-readable media having computer-readable instructions thereon which, when executed by a computer, implement the method of claim 37.

42. (Original) A programmable computer having a memory and a processor, the memory containing software code which causes the processor to execute the method of claim 37.

43. (Original) A computer graphic processing system comprising a programmable computer programmed with computer-readable instructions which, when executed by the programmable computer, implement the following method:

defining a plurality of polygons that approximate an object, individual polygons having a plurality of vertices;

casting a ray toward the approximated object;

defining at least one plane relative to the approximated object to contain the ray;

pre-characterizing the vertices of the plurality of polygons to provide characteristic data that describes the positions of the vertices relative to said at least one plane;

using the characteristic data to ascertain the positions of the individual polygons relative to said at least one plane;

determining which of the individual polygons might be intersected by the ray, based upon their ascertained positions, to provide a sub-set of polygons; and

evaluating the sub-set of polygons to ascertain which of the polygons are intersected by the ray.

44. (Original) The computer graphic processing system of claim 43, wherein said defining of the plurality of polygons comprises defining a polygon mesh.

45. (Original) The computer graphic processing system of claim 43, wherein said defining of the plurality of polygons comprises defining a polygon fan.

46. (Original) The computer graphic processing system of claim 43, wherein said defining of the plurality of polygons comprises defining a polygon strip.

47. (Original) The computer graphic processing system of claim 43, wherein said defining of said at least one plane comprises defining said plane to be parallel to one of the x, y, and z axes.

48. (Original) One or more computer-readable media having computer-readable instructions thereon which, when executed by a computer graphic processing system, implement the following method:

defining a plurality of triangles that approximate an object, individual triangles having three vertices;

casting a ray toward the approximated object;

defining at least one plane relative to the approximated object to contain the ray;

pre-characterizing the vertices of the plurality of triangles to provide characteristic data that describes the positions of the vertices relative to said at least one plane;

using the characteristic data to ascertain the positions of the individual triangles relative to said at least one plane;

determining which of the individual triangles might be intersected by the ray, based upon their ascertained positions, to provide a sub-set of triangles; and

evaluating the sub-set of triangles to ascertain which of the triangles are intersected by the ray.

49. (Original) The one or more computer-readable media of claim 48, wherein said defining of the plurality of triangles comprises defining one of a triangle mesh, a triangle strip, and a triangle fan.

50. (Original) A computer graphic processing system comprising:

a processor;

memory; and

software code stored in the memory that causes the processor to implement a ray-intersection algorithm which:

casts a ray at a collection of shapes that approximate an object;

defines a reference object that contains the ray;

pre-characterizes aspects of individual ones of the shapes of the collection to provide characteristic data; and

uses the characteristic data to ascertain the position of the shapes of the collection of shapes relative to the reference object.

51. (Original) The computer graphic processing system of claim 50, wherein the ray intersection algorithm casts a ray at a collection of polygons, each of which have similar geometries.

52. (Original) The computer graphic processing system of claim 50, wherein the ray intersection algorithm casts a ray at a collection of triangles.

53. (Original) The computer graphic processing system of claim 52, wherein the collection of triangles defines a triangle mesh.

54. (Original) The computer graphic processing system of claim 50, wherein the ray intersection algorithm pre-characterizes aspects of the shapes by computing positions of various sub-components of the shapes relative to the reference object.

55. (Original) The computer graphic processing system of claim 54, wherein the reference object comprises at least one plane.

56. (Original) The computer graphic processing system of claim 55, wherein the shapes comprise polygons and the sub-components comprise vertices of the polygons.